OATS

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OHIO AGRICULTURAL EXPERIMENT STATION

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BULLETIN

OF THE

Ohio Agricultural Experiment Station

NUMBER 257 FEBRUARY, 1913.

OATS

COMPARISON OF VARIETIES, FERTILIZATION, PREPARATION OF SEED BED, TIME OF SEEDING, RATE OF SEEDING, QUALITY OF SEED, IMPORTED vs. HOME-GROWN SEED, PROTEIN CONTENT, BARLEY AND OTHER SPRING CROPS

C. G. WILLIAMS AND F. A. WELTON

Twenty years have now elapsed since the Ohio Station was moved to its present site near Wooster. Each season during that time many experiments with oats have been conducted. The reports of the published results may be found in the following:

Bulletin No. 57 issued in December, 1894.
Bulletin No. 67 issued in February, 1896.
Bulletin No. 101 issued in March, 1899.
Bulletin No. 138 issued in March, 1903.
Circular No. 88 issued in February, 1909.

This bulletin brings the report of this line of the Station's work to the close of the season of 1912. In it are given data regarding varieties, fertilization, preparation of seed bed, time and rate of seeding, size and source of seed, protein content, and tests with a few varieties of barley and other spring crops.

On account of variations in seasons, the results obtained in any one year are less valuable than are those representing the average of a series of years, and, generally speaking, the longer the average the more valuable the results. Therefore, as far as possible, in this bulletin the new data have been averaged with the old, i. e. with that reported in Circular 88 and Bulletin 138, thus bestowing a value which time alone can give.

VARIETIES

In the course of the past twenty years, 175 so-called varieties have found their way into the Station's variety test plots. Probably many of these differ from each other only in name. Be that as it may, however, this profusion of names presents a real and fundamental problem to the grower of oats—namely, to weed out the poor and to find the comparatively few true varieties of high merit.

For work of this kind the Ohio Station has a fifty acre tract of land which is divided into four tiers of one-tenth acre plots, two of which tiers contain 100 plots each and two, ninety each. On this piece of land a four-course rotation of corn, oats, wheat and clover is followed in the order named. With the clover is seeded a little timothy. Originally this body of land was quite even and similar treatment for twenty years has made it still more uniform. Throughout the entire period not an implement employed in the preparation of the seed bed has been used on one plot but what it has been used an equal amount on every other plot the same day. The fertilization of each is the same, reference to which will be made again under the heading of "Fertilization."

To overcome in part the unavoidable variations of soil, every third or fourth plot is always seeded to the same variety called a "check," and the yields of the varieties tested, are then corrected by the yields of the check before being compared with each other. Throughout the past ten years the check has been the same variety—the Wideawake.

This plan permits the testing of fifty or sixty varieties each season. Varieties are usually grown at least five years, at the end of which time they are either dropped or continued, according to their past record. The dropping of the poorer varieties makes room for the new ones which are continually appearing on the market, and for the selections which the Station is developing through its plant-row work, a few of the more promising of which are included in the list of varieties hereinafter reported upon.

The selections are designated by a number before which is placed the word "Ohio." The first figure, to the left, in the number indicates the year in which the selection was first grown; the three to the right, the consecutive number of the selection in the plant-row test. The word to the right indicates the name of the variety from which the original head was selected. For instance, Ohio 6222—Improved American, means that that strain was derived from a single head of Improved American oats and that its origin dates back to the year 1906.

In the season of 1912, thirty-six of the fifty odd varieties tested were varieties which had been grown for a period of five or more years—a sufficiently long period upon which to base fairly safe conclusions as regards comparative yield and other important characters. The others were newcomers, including many selections of various ages, and for that reason will not be considered in this bulletin.

Descriptive data regarding the thirty-six varieties are given in Table I. The grain of each is described with reference to its color, size, percentages of hull and kernel and weight per bushel. The plants, as regards time of heading, character of panicle, height, stiffness of straw, and length of season.

TABLE I. Description of thirty-six varieties of oats.

Variety	Grain					Plant					
			Percent of			Heading					
	Color	No. kernels per oz.	Hull	Kernel	Av. wt. per bu.	First	Full	Side or branching	Av. height in.	Stiffness of straw	No. days from planting to maturity
Alaska	White	1,314	24.3	75.7	28.45	6-19	6-28	Br.	39	74	101
American Banner	"	1,056	29 0	71.0	28.05	26	7-4	"	37	86	106
Beardless Propsteier	Yellow	1,029	25.6	74.4	27.67	28	6	"	41	80	107
Big Four	White	1,083	29 2	70.8	29.35	25	2	"	39	82	105
Black Mogul	Black	1,233	36.7	63.3	23.55	7-2	7	"	39	96	112
Clydesdale	White	1,330	28.3	71.7	27.90	6-27	4	"	38	86	106
Czar of Russia	"	1.049	27.3	72.7	27.95	27	4	"	42	79	106
Early Champion	"	1,440	24.5	75.5	28.45	18	6-25	"	39	67	101
Golden Fleece	"	920	29.0	71.0	28.55	24	7-3	"	39	77	103
Golden Rain	Yellow	1,173	25.8	74.2	30.85	25	3	"	41	85	103
Green Mountain	White	1,017	30.9	69.1	27.80	28	5	"	38	90	107
Hvitling	"	952	23.9	76.1	28.00	28	4	"	39	82	107
Improved American	"	1,114	27.8	72 2	28.50	27	4	"	39	88	106
Joanette	Black	1,146	24.0	76 0	29.25	23	2	"	35	84	111
Lincoln	White	1,032	27.8	72 2	28.10	25	4	"	42	81	99
Long's White Tartar	"	1,033	30 8	69.2	29.40	23	1	Side	41	90	104
Morgan Feller	"	1,016	27.8	72.2	27.25	27	5	Br.	39	84	106
Ohio 6222-Impr. Amer.	"	1,085	27 0	73.0	29.62	27	7	"	39	90	105
Ohio 6203-Siberian	"	857	25 5	74 5	29.95	23	1	"	40	84	105
Ohio 6106-Sixty Day	Yellow	1,497	27.3	72.7	28.65	14	6-21	"	36	78	94
Ohio 7009-Sixty Day	White	1,468	27.0	73.0	25.35	14	21	"	36	82	94
Seizure	Yellow	1,276	30.3	69.7	26.35	28	7-7	Side	39	91	110
Sensation	White	1,035	26.8	73.2	28.50	24	2	Br.	38	78	108
Siberian	Wh.yel.	907	26.8	73.2	27.80	24	1	"	40	85	105
Silver Mine	White	1,181	26 9	73.1	27.65	24	1	"	39	83	103
Sixty Day	Yellow	1,384	25.8	74.2	27.95	15	6-21	"	35	80	96
Sparrowbill	White	1,265	35.1	64.9	28.30	29	7-6	"	38	89	109
Storm King	"	751	31.3	68.7	25.20	24	1	Side	38	95	104
Swedish Select	"	823	27.0	73.0	28.70	26	4	Br.	38	82	101
Swedish Sel., Regenerated	"	825	25 5	74.5	28.45	24	1	"	37	78	106
Twentieth Century	"	1,075	28 0	72.0	27.85	25	3	"	39	81	105
Watson	"	1.4·6	35.5	64.5	27.00	25	2	Side	50	88	109
Welcome	"	1,523	28.1	71.9	27.05	26	6	Br.	40	73	104
White Ligowa	"	863	26 0	74.0	28.65	25	3	"	39	80	105
White Propsteier	"	975	27.8	72.2	27.02	29	5	"	42	82	108
Wideawake	"	1,268	26.5	73.5	29.32	24	3	"	40	73	100

The extremes in size of kernel are represented by the Storm King and the Welcome, which have 751 and 1523 kernels per ounce, respectively—a matter of some moment as regards rate of seeding. Column five gives the weight per measured bushel of each variety before recleaning. In order to prevent the mixing of varieties, the

Station uses a special thresher, the construction of which is such that it does not clean grain as thoroughly as does the ordinary threshing machine, hence the low weights per bushel. The weights, however, are comparable.

The yields of the same thirty-six varieties are presented in Table II, in which are given also the pounds of straw per bushel of grain and the rank of the varieties based upon the following: five-year average yield, five-year average weight per bushel and percent of kernel.

The variation in yield of grain from year to year, as shown by the average of the seventeen varieties which have been grown throughout the ten years, is due largely to differences in climatic conditions and to ravages of insect pests and fungous diseases.

Upon the basis of the nine-year average* yield, the highest five in the order of their rank are as follows: Siberian, Big Four, Silver Mine, Improved American and Sixty Day. Among these the Improved American has perhaps the stiffest straw, as is shown in Table I under the heading of "stiffness of straw."

In order to compare with the older varieties the more recent introductions, including four Station selections, all were averaged for five years, and upon this basis the highest five in the order of their rank are: Ohio 6203—Siberian, Ohio 7009—Sixty Day, Siberian, Ohio 6222—Improved American and Ohio 6106—Sixty Day. A comparison of the yield of each selection with that of its parent variety, shows that with three exceptions all the selections have yielded higher than their parents every year throughout the five years. In many cases, however, the difference is well within the limits of experimental error.

In 1910, Ohio 6203—Siberian was grown in six cooperative tests on one-twentieth acre plots at points distributed over the state as follows: Paulding, Paulding Co.; Findlay, Hancock Co.; Germantown, Montgomery Co.; North Fairfield, Huron Co.; Mansfield, Richland Co.; and Tacoma, Belmont Co.

With the exception of the test at Tacoma which did not include a plot of the original Siberian, the selection yielded higher than the original in every test, the average gain being 4.8 bushels. Its rank in the six tests consisted in two firsts, two seconds, one third and one sixth. The number of varieties per test ranged from four to eleven.

*This average was made in order to include in a long-time average, prominent varieties introduced in 1904.

TABLE II. Comparative test of thirty-six varieties of oats.

Variety	Bushels of grain and pounds of straw per acre															Pounds straw per bu. grain 5 yr. av.	Rank based upon		
	Grain													Straw			5 yr. average		Percent of kernel 1 yr.
											Average of			Average of			Yield	Wt. per bu.	
	1903	1904	1905	1906	1907	1908	1909	1910	1911	1912	10 yrs.	9 yrs.	5 yrs.	10 yrs.	5 yrs.				
Alaska	35.95	72.51	63.65	71.46	44.71	49.86	62.28	60.17	68.91	73.08	60.26	62.96	62.86	2,813	3,243	52	25	12	3
American Banner	45.63	83.40	58.18	77.59	47.81	65.78	67.04	64.57	70.06	75.22	65.53	67.75	68.53	3,051	3,603	53	12	15	18
Beardless Propsteier	....	....	....	....	....	53.74	62.67	52.89	57.10	74.00	....	....	60.08	....	3,677	61	33	21	6
Big Four	44.36	82.32	68.48	83.23	49.23	58.44	66.98	75.82	69.84	80.03	67.87	70.49	70.22	2,844	3,371	48	6	5	19
Black Mogul	....	....	....	....	....	44.25	52.46	53.07	29.04	48.83	....	....	45.53	....	4,225	93	36	30	26
Clydesdale	42.65	77.76	46.59	74.74	46.68	48.55	60.81	68.69	55.69	72.48	59.46	61.33	61.24	3,191	3,767	62	28	18	17
Czar of Russia	41.57	71.69	63.72	81.62	45.69	71.03	69.99	66.89	61.89	79.67	65.38	68.02	69 89	2,982	3,486	50	8	17	13
Early Champion	26.96	62.80	56.58	67.55	42.73	62.87	63.65	60.83	65.99	69.32	57.93	61.37	64.53	2,655	3,267	51	21	12	4
Golden Fleece	34.95	70.79	59.56	74.21	36.48	70.69	56.58	62.97	60.44	73.77	60.04	62.83	64 89	2,579	2,933	45	19	10	18
Golden Rain	....	....	....	....	....	61.98	72.52	69.22	65.51	78.31	....	....	69.51	....	3,686	53	9	1	7
Green Mountain	46.89	82.54	58.96	88.12	45.03	68.86	69.29	53.56	59.01	77.06	64.93	66.94	65.56	3,007	3,338	51	17	20	22
Hvitling	....	....	....	....	....	63.55	69.09	49.50	53.62	65.33	....	....	60.22	....	3,276	54	30	16	1
Improved American	46.76	85.66	59.45	87.21	45.47	67.18	73.51	63.48	65.83	77.05	67.16	69.43	69.41	3,103	3,565	51	10	11	14
Joanette	....	79.76	66.40	81.26	43.58	73.69	67.37	51.88	62.44	78.81	....	67.24	66.84	....	3,630	54	14	7	2
Lincoln	48.95	76 52	60.24	80.95	46.60	61.75	66.67	65.67	67.55	79.88	65 48	67.31	68.30	3,061	3,471	51	13	14	14
Long's White Tartar	38.22	73.66	44.33	86.97	50.63	51.09	66.09	76.92	64 68	72.03	62.46	65 16	66.16	2,830	3,313	50	15	4	21
Morgan Feller	41.04	75.47	62.18	80.63	45.24	69.35	60.53	67.62	55.71	77.07	63.48	65.98	66.06	3,010	3,412	52	16	23	14
Ohio 6222-Improved American	....	....	....	....	....	70.58	73.81	64.73	67.17	77.71	....	....	70 80	....	3,140	44	4	3	12
Ohio 6203-Siberian	....	....	....	....	....	71.36	73.11	74.11	70.69	78.15	....	....	73.48	....	3,203	44	1	2	5
Ohio 6106-Sixty Day	....	....	....	....	....	68.52	77.55	73 83	58.98	77.06	....	....	71.19	....	2,442	35	5	9	13
Ohio 7009-Sixty Day	....	....	....	....	....	75.33	76 87	73 96	53.19	82.05	....	....	72 28	....	2,457	34	2	28	12
Seizure	40.94	75.83	60.79	74.81	38.23	58.47	59.06	48.32	68 15	66.52	59.11	61.13	60.10	3,310	3,690	61	31	27	20
Sensation	....	....	....	73.65	45.28	68.00	62.45	59.14	60.30	77.03	....	....	65.38	....	3,106	48	18	11	10
Siberian	....	93.66	65.09	78.88	49.06	65.63	71.35	76.61	67.35	74.34	....	71.33	71.06	....	3,168	45	3	20	10
Silver Mine	48.61	84.07	64.50	82.55	47 14	60.12	67.37	72.07	70.97	79.39	67.68	69.80	69 98	2,854	3,386	48	7	22	11
Sixty Day	....	87.16	55 62	71.37	56.95	75.72	71.73	70.88	51.33	73.31	....	68.23	68.59	....	2,448	36	11	17	7
Sparrowbill	....	....	....	79.99	51.57	48.79	56.57	40.15	54.07	58.74	....	....	51 66	....	3,320	64	35	13	24
Storm King	....	....	....	80.05	44.34	5' 07	66.69	79.30	59.59	66.98	....	....	64 73	....	3,811	59	20	29	23
Swedish Select	....	81.89	51.84	71.69	47.30	66.75	61.60	70.31	39.64	62.16	....	61.46	60.09	....	3,234	54	32	8	12
Swedish Select, Regenerated	....	....	....	....	....	62.37	59.05	59.34	54.99	68.11	....	....	60.77	....	2,925	48	29	12	5
Twentieth Century	40.30	72.39	59.95	80.58	40.87	66.57	58.10	59.98	53.54	77.44	60.95	63.25	63 09	2,696	3,102	49	23	19	15
Watson	....	73.39	47.24	78.08	51.13	50.19	69 10	76.95	50.24	61.72	....	62 00	61 64	....	3,610	59	27	26	25
Welcome	46.08	73.76	55.25	72.24	48.70	47.21	70.19	65.82	62.36	70.60	61 22	62.90	63.23	3,218	3,803	60	22	24	16
White Ligowa	....	....	....	....	....	65.41	62.60	60.32	56.71	69 90	....	....	62 99	....	3,015	48	24	9	8
White Propsteier	....	....	....	....	....	54.10	65.28	60.98	52.66	77.56	....	....	62 12	....	3,682	59	26	25	14
Wideawake	44.43	77.26	56.65	73.02	40.20	50.19	55.42	61.76	56.16	73.74	58 88	60.49	59.45	3,431	3,922	66	34	6	9
Av. yield of 17 varieties	42.02	77.92	58.40	78.12	45.88	61.81	65.21	65.53	61.26	73.85	62.80	65 34	64.77	2,978	3,354				

In 1911, this selection exceeded the original by 3.19 bushels and ranked third in a test embracing seven varieties at Carpenter, Meigs Co., and exceeded the original by 6.88 bushels and ranked first in a test embracing four varieties at Germantown, Montgomery Co.

In 1911, Ohio 6222—Improved American was grown in cooperative tests at Madison, Lake Co., and at Bolivar, Tuscarawas Co. In both it exceeded the yield of the original, the average gain being 6.15 bushels, and in both tests, which contained eleven varieties each it ranked first.

In 1912, small variety tests were conducted on the Station's Paulding and Miami County test farms. At Paulding the rank of Ohio 6222—Improved American, Ohio 6203—Siberian and Ohio 7009—Sixty Day was first, second and eighth respectively. At the Miami Co. test farm, Ohio 6222—Improved American was not grown. The rank of Ohio 6203—Siberian and Ohio 7009—Sixty Day was fifth and sixth respectively. These facts would seem to indicate that these are selections of some merit.

On the basis of the five-year average yield of straw there was a difference of 1,783 pounds per acre as between the highest and lowest—a difference worthy of consideration if oats are to be harvested for hay. Among the varieties best suited to this purpose, either when they are grown alone or with some other crop like field peas, may be mentioned such as the Siberian, Watson, Wideawake, Storm King, Welcome and others. On account of the very low yield of grain produced by the Black Mogul it can hardly be recommended, although it has made an exceptionally high yield of straw.

In Bulletin 138, Table I, is given, among other things, the ten-year average yield of all varieties tested by the Station during the years 1893-1902 inclusive. In Table II of this bulletin is given the ten-year average yield of those varieties grown during the years 1903-1912 inclusive. Several varieties have been grown ten or more years, which do not appear in either of these tables for the reason that they were introduced at some time in the midst of the first ten-year period and were dropped before the close of the last ten-year period. In order to include these, and in order to have in a readily available form all varieties having a record of ten or more years on the Wooster soil, Table III was prepared, and for the sake of comparing all those with a single ten-year record with as many as possible of those having a longer record, the latter have been averaged for each consecutive ten year period. In this table are given also the fifteen and twenty-year average yields of such varieties as have been grown that length of time.

TABLE III. Comparative yield of sixty-four varieties of oats.

Variety	Ten-year averages											15-year average		20-yr. a.v
	*1893-1902	1894-1903	1895-1904	1896-1905	1897-1906	1898-1907	1899-1908	1900-1909	1901-1910	1902-1911	1903-1912	1893-1907	1898-1912	1893-1912
Alabama	48.97	51.35	54 32	54.22	.....	.....	.....	.....	. ...	.....	.....	.....	.....	. ...
Alaska	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	60.26	.....	.....	.....
American Banner	54 55	55.41	59.86	60.78	62 31	59 96	61.56	61.99	62.96	65.66	65 53	57.21	62.82	60.04
Badger Queen	51 93	52.90	56.47	57 90	.....	. ...	.....	....	. ...	.....	.....	.....	.....	.....
Banner	48.42	.....	....	.....	. ..	...	.....	.....	.....	.....	.....	. ...	.....	.....
Barley Oats	51.49	52.77	55.79	.....	....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Big Four	...	....	...	.....	. ...	.....	58.46	59.66	62.94	65.74	67.87	.....	.....	.....
Black Beauty	43.18	44.08	47.55	.....	.....	.....	.....	.....	.....	.....	....	.....	.....	.....
Black Tartarian	45.51	.....	.....	....	.....	.....	.....	.....	.....	.....	.....	.....	.....	... .
Bolton	.....	51.18	55.78	56.89	.....	.....	....	.....	.....	.....	.....	.....	.....	.....
Bonanza King	.....	51.70	55.33	. ...	....	.. ..	.....	....	. ...	.....	.....	.....	.....	.....
Centennial	52.93	54.32	57 57	57.33	...	.....	.....	.....	...	.....	....	.....	.. .	.....
Colonel	54 62	55.72	58 92	58.95	59.94	57.75	. ...	.....	.....	.....	.....	56 38	.....	.....
Clydesdale	53.39	54.85	58.14	56 74	57 65	55.34	56.07	56 76	57.84	59.56	59 16	54.82	57.31	56.43
Czar of Russia	.....	.....	.....	.....	.....	....	.....	.....	.....	.....	65.38	.....	.....	.....
Dakota Gray	46.86	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Early Archangel	48.97	50.18	54.58	56.46	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Early Champion	.....	.....	. ..	.....	.....	.....	.....	. ...	.....	. ...	57.93	.....	.....	.....
Early Dakota	46.40	47.88	52.40	54.28	56.83	54.91	.....	.....	.....	....	.....	51 61	... .	.....
Early Prize Cluster	47.85	49.56	.....	.....	. ...	. ...	.....	.....	.....	.....	.....	.....	.....	.....
Early Swedish	52.98	54.82	57 82	58.06	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Early White Maine	44.38	45.53	50.61	52.66	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Egyptian	48 52	50 16	....	....	.....	.. .	.....	. ...	. ...	.....	.....	.....	.....	.....
Everett's Negro Black	44.09	45.32	48.95	51 42	.....	....	.....	.....	....	.....	.....	.....	.....	.....
Excelsior	50 35	52.40	. ...	.....	.....	....	. ...	.....	.....	.....	.....	. ...	.....	.....
Giant Yellow French	45.79	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Golden Fleece	.....	.....	.....	.....	.....	.....	...	.....	.....	.....	60 04	.....	.....	.....
Great Northern	44.41	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Green Mountain	.....	52 84	57.53	58 94	60.77	58 99	60.98	61.76	61.91	63.44	64 93	.....	61.18	.....
Hargett's White	46 66	47 93	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Heavy Weight	.....	48.56	52.02	... .	.....	.....	.....	.....	.....	.....	. ...	.....	.....	.....
Henderson's Clydesdale	52.18	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Hopetown	43.95	....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Improved American	54.38	55 30	59.26	59.90	61.82	59 43	61.55	62.80	63.63	66.19	67.16	57.89	62 76	60.77
Japan	50.84	52.06	55.10	55 24	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Kansas Hybrid	51.49	52 28	56 16	57.02	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Lincoln	52 20	53 54	58.01	59.94	61.36	59.55	61 06	61.36	62.06	64 66	65.48	55.69	62 47	58.84
Long's White Tartar	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	62.46	. ...	.....	.....
Monarch	42.44	43.14	47.12	49 24	52.34	51.70	53.44	54.31	56.65	.....	.....	48.11	.....	.....
Morgan Feller	.....	.....	.....	.....	....	.....	.....	.....	.....	.....	63.48	.....	.....	.....
New Baltic	44.45	45 58	50.30	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

TABLE III. Comparative yield of sixty-four varieties of oats.—Concluded.

Variety	Ten-year averages											15-year average		20-yr. av.
	*1893-1902	1894-1903	1895-1904	1896-1905	1897-1906	1898-1907	1899-1908	1900-1909	1901-1910	1902-1911	1903-1912	1893-1907	1898-1912	1893-1912
New Zealand				53.64										
Poland	47.28	48 56	53.62	56.63										
Potato Oats	44.22	45.96	49.76											
Pride of America		48 80	53.61											
Prince Edward Islands	45.84													
Probsteier	47.85	49.78	52.87	53.81										
Race Horse	46.14	47.94	53.55	54.92										
Scottish Chief	48.92	51.41	55.69	56.66										
Seizure	48.01	50.60	53.74	53.85	55.80	53.00	55.04	55 41	55 82	59.08	59.11	51.38	55.37	53.56
Silver Mine						56.81	60 25	62 33	63 91	67.02	67.68		61.20	
State of North Dakota	46.38	47.76	50.86											
Twentieth Century											60.95			
Welcome									58.82	60.91	61.22			
White Belgian	52.61	54.09	57.40	57.83										
White Bonanza	51.13	51.47												
White California	49.68	52.33	55.78	55 46										
White Schoenen	44.58													
White Swiss	53.56	55.10												
White Victoria	48 99	50.22	54.10	56.57										
White Wonder	47 20	47.80	52 22											
Wideawake	47.40	48.89	52 72	54.56	56.55	54 50	55.02	55.24	56 56	57.72	58.88	51.04	56.15	53.14
Wilson's Prolific	51.21	52.11	55.28	56.06	59.52	58 26	59.56	59.49	61.45			55.37		
Yankee Prolific	45.72													

*Yields have been corrected by "check," hence the slight variation in yields from those for the same period given in Table I, bulletin 138.

FERTILIZATION

A glance at the eleven consecutive ten-year average yields, of the six varieties which have been grown throughout the twenty years, shows a gradual gain, due, in part, to better soil adaptation[1] and, in part, to increased fertility of the soil. This progress, however, is better shown in Table IV, where the yields of the six varieties are given by five-year periods, and where is shown also the increase from period to period. The notable gain between the second and third period is probably due to the present system of fertilization, which was inaugurated in 1903—the year which marks the beginning of the third period.

TABLE IV. Yield and increase by five-year periods.

Varieties	Yield by five-year periods				Increase from period to period		
Amer. Banner... Clydesdale .... Improved Amer. Lincoln..... Seizure..... Wideawake.....	First 1893-1897	Second 1898-1902	Third 1903-1907	Fourth 1908-1912	Second over First	Third over Second	Fourth over Third
Av. of 6 varieties	50.08	53.23	60.70	64.50	3 15	7.47	3.80

Prior to that time, the complete system of fertilization consisted in an application of eight to ten tons of manure, as a top dressing to the wheat ground. Since then, phosphated manure, commercial fertilizers and lime have been added per rotation as follows: Eight to ten tons manure, to which has been added forty pounds per ton of rock phosphate, have been applied to the clover sod in the fall and winter and plowed under in the spring for corn; one-half ton[2] of quick lime, or its equivalent of ground limestone, has also been applied to the corn ground shortly after plowing; and approximately four hundred pounds per acre of commercial fertilizer have been added to the wheat ground—a fertilizer made from a mixture of steamed bone, acid phosphate, potassium chloride and sodium nitrate,[3] of which the average analysis is substantially 2.5-18-4; and one of which the cost, according to Vivian's[4] simple though comparatively accurate rule of computation—a rule which applies only to purchases made through agents, would be approximately $34.50[5] per ton.

Has the latter system paid?

[1]Proceedings of the American Society of Agronomy Vol. III, pp. 65-72.

[2]The initial application made in 1903 consisted of one ton per acre of quick lime.

[3]Sodium nitrate is applied in the spring. Sometimes the application is omitted, depending upon the condition of the wheat.

[4]Multiply the percentage of nitrogen by 3, add the product to the percentages of available phosphoric acid and potash and the result will be the commercial value of a ton of the fertilizer in dollars and cents. The selling price of a given fertilizer should not exceed the value thus determined by more than $5.00. In case the analysis states ammonia instead of nitrogen, the ammonia should be multiplied by two and one-half.

[5]In carload lots, after allowing $2.00 for handling, the cost of the materials out of which this mixture is made is such that the value of the mixture would aggregate approximately $26.00 per ton.

The five-year average yields of all crops in the rotation for the last half of each ten-year period, i. e. for the years 1898-1902 and 1908-1912 inclusive, should offer a good basis of comparison for the two systems—one entirely fair to the first because it is always easier to make gains on poor than on rich soil. That the soil was richer at the close than at the beginning of the first ten-year period is shown by reference to the afore-mentioned ten-year average yields in Table III and, in a more striking manner, by the figures in Table IV.

Such a comparison is made in Table V in which also is given the total and net value of gain, and the cost of fertilizers and limestone per rotation. In the final column is shown the net value of gain per year. All valuations are computed on an acre basis.

TABLE V. Comparison of old and new systems of fertilization.

Period	Bushels per acre			Tons hay per acre	Cost of fertilizers and limestone per rotation[4]	Value of gain per rotation		Net value of gain per year
	Corn	Oats	Wheat			Total	Net	
Five-year av. yield, 1898-1902	52 37	51 53	19 66	2 50				
Five-year av. yield, 1908-1912	76 34	63 71	32 93	3 54				
Gain of latter over former	23 97	12 18	13 27	1 04				
Value of gain[3]..	$11 98	$ 4 06	$11 94	$8 32	$10 30	$36 30	$26.00	$6 50

In the above table no credit has been allowed for the straw and stover which would approximate for each rotation three and one-quarter tons of the former and two tons of the latter. This amount of straw and stover ought to compensate for the extra expense of applying fertilizer and limestone, and the harvesting of the larger crops.

From the above table it will be noted that the system of fertilization adopted in 1903 is one which has given an average annual net return of $6.50 per acre and for that reason it is one which would seem to give a most emphatic affirmative answer to the oft repeated question—Has it paid? In this system no fertilizer is given the oats directly. This crop acts in the capacity of a gleaner.

The soil is one derived principally from a sandy shale, lying upon the upper strata of the Waverly series. It bears the markings of glacial action and is known as a silt loam.

[3]Crops valued as follows: Corn, 50 cts. per bushel; oats, 33⅓ cts. per bushel; wheat, 90 cts. per bushel; hay $8.00 per ton.

[4]Commercial fertilizer here valued at $34.50 per ton; floats at $8.00 per ton; limestone, including freight, at $1 80 per ton. Value of manure not considered because the rate of application throughout the twenty years has remained constant.

PREPARATION OF SEED BED

How best to prepare a seed bed for oats is a question of economic importance to all growers of this crop and one about which there is much difference of opinion. Some contend that plowing or deep working of stubble ground is unnecessary; that thorough disking or surface preparation is sufficient. Others go still further and advocate the seeding of oats on stubble ground early—in February or March—without any previous preparation, depending upon subsequent freezing and thawing to cover the seed. They put great emphasis upon the importance of earliness.

To get data on these points an experiment was started in 1909 in which oats were seeded under the following conditions: First, on corn stubble land without any previous preparation and as early as the weather and soil conditions would permit; second, on land thoroughly disked with a double action cutaway harrow; third, on land plowed six or seven inches deep and subsequently fitted thoroughly. In all cases the oats were seeded by means of a disk drill and at a uniform rate per acre. The test has been run in duplicate on one-twentieth acre plots for four years, and in each of these a different variety of seed has been used. Data regarding time of seeding, yield of grain and straw, pounds of straw per bushel grain and weight per bushel, are given in Table VI.

From the table it will be noted in each of the four years that the average of the disked plots is highest; that with the exception of one year—1909—the average of the plowed plots is higher than that of the ones receiving no previous preparation, and that upon the basis of the average of all (eight) tests for the four years, the yield of the disked plots exceeds that of the plowed by 3.34 bushels per acre and that of the one receiving no previous preparation by 4.63 bushels.

So far as plowing and disking are concerned, these results indicate that disking for oats is a commendable practice in Wayne and other counties having similar soil, which is not too weedy. In some years weeds have gained considerable headway in the unplowed plots thus indicating that the practice might be questionable on foul land. In fact, earlier work of this Station, done at a time when the Station farm was not as free from weeds as now, resulted in a six-year average gain of 4.10 bushels in favor of plowing.* Where weeds make plowing a necessity, this may well be done in the fall or winter, providing the type of soil and topography of farm permit.

*Ohio Bulletin 138, page 46.

The practice of seeding without previous preparation of seed bed seems to hold out little hope under conditions such as prevail in this section. On other types of soil, however, the results in this regard might be different.

TABLE VI. Preparation of seed bed.

Seed bed	Time of seeding	Bushels grain per acre. Av. of two plots	Pounds of straw per		Weight per bushel
			Acre	Bushel grain	
1909					
No preparation	Mch. 31	49.45	3,437	69.5	27 25
Disked	Apr. 5	50.08	2,847	56.8	28.12
Plowed	Apr. 5	45.15	2,895	64.1	25 62
1910—Improved American					
No preparation	Mch. 17	49.06	3,150	64.3	29.25
Disked	Mch. 26	57.26	3,447	59 3	30.00
Plowed	Mch. 26	53.12	3,100	58.3	29.00
1911—Ohio 7009 Sixty Day					
No preparation	Mch. 22	62.81	1,320	20.7	32.87
Disked	Mch. 22	68.82	1,807	26.3	32.62
Plowed	Mch. 22	66.56	1,890	28.4	31.62
1912—Ohio 8079 Big Four					
No preparation	Apr. 6	68 12	3,605	52 9	33.25
Disked	Apr. 25	71.79	3,222	44.9	30.87
Plowed	Apr. 25	69.76	3,267	46 8	31.75
Average of eight tests extending over four years					
No preparation	Mch. 17 to Apr. 6	57 36	2,878	51.8	30.65
Disked	Mch. 22 to Apr. 25	61.99	2,831	46.8	30.40
Plowed	Mch. 22 to Apr. 25	58.65	2,788	49.4	29.50

The fact that the lowest yielding plot, i. e. the one receiving no preparation, was, with one exception, seeded earlier each year—from five to nineteen days—than the other two, suggests an investigation of the importance of early seeding under uniform conditions.

TIME OF SEEDING

To get data of this nature a test was started in 1906, the general plan of which was to make seedings at stated intervals throughout the oat seeding season, including the extreme dates, but under conditions otherwise uniform. Climatic and soil conditions have often interfered with the regularity of the various seedings as may be

seen by reference to Table VII. From year to year representative varieties as regards earliness have been used as seed, and the size of the plots has varied from one-twentieth to one-tenth acre.

During each of the first three years five seedings were made, the interval between each two ranging from seven to nine days. In 1909, 1910 and 1911* the number of seedings per year was reduced to four and the intervals correspondingly increased, ranging from nine to fourteen days. Since the four seedings were made to cover practically the same period as were the five originally, it has seemed best to average the results of each separately and to present the one in Part A; the other in Part B of Table VII.

Considering the results in the two parts of the table it will be noted that they are not altogether harmonious. In the years 1907 and 1909, for instance, the yields of grain are quite inconsistent, and in both cases the earlier seedings yielded less than some of the later. With the exception of the year 1909 the yield of straw throughout the six years is very irregular.

On the other hand, attention should be called to the fact that in two years—1910 and 1911—the yield of grain decreased with each succeeding date of seeding, and that in two other years there was a gradual rise in yield, after which followed a gradual falling off, the crest being reached on the second date in 1906 and on the third date in 1908. Averaging the yields of grain for the first three years of the test, the second date exceeds all others; the first by 1.27 bushels; the third by 2.65 bushels; the fourth by 4.60 bushels and the fifth by 9.74 bushels. Averaging the yields for the years 1909-10-11, the first date wins, outyielding the second by 5.02 bushels, the third by 13.56 bushels and the fourth by 18.37 bushels.

Regarding weight per bushel, there have been inconsistencies in some years, but each of the three-year averages shows a gradual falling off in weight per bushel as the season advances.

All things considered, therefore, the results to date seem to indicate that early seeding is desirable.

THICK AND THIN SEEDING

Regarding rate of seeding, the best guide is that obtained by comparing long-time average yields from different rates of seeding. Such information is presented in Table VIII, which gives results from nine different rates of seeding, ranging from four to twelve pecks and extending over nine years. In this work fourteen distinct tests on one-twentieth acre plots have been conducted and four representative varieties as regards size of kernel and length of season have been used. In all cases the seed has been thoroughly recleaned before seeding.

*No test in 1912 due to extreme lateness of season.

TABLE VII. Part A. Early and late seeding of oats.

	1906—Siberian					1907—Improved American					1908—Wideawake					3 yr average—1906-07 08				
Date of seeding	4-7	4-16	4-21	4-28	5-5	4-4	4-12	4 18	4-29	5-10	3 30	4-6	4-13	4 21	4 27	3-30 to 4 7	4-6 to 16	4-13 to 21	4 21 to 29	4-27 to 5-10
Yield { Grain	68 91	71 87	65 31	58 28	56 25	46 09	46 33	43 36	49 53	44 45	56 72	57 34	58 91	53 91	45 62	57 24	58 51	55 86	53 91	48 77
Yield { Straw.	1 995	2,120	2 090	2 035	3 720*	1,955	1,867	1 732	1 965	1,947	3,285	3 315	3,135	3 175	2 690	2,412	2,434	2 319	2 392	2 318
Straw per bu grain	28 90	29 50	32 00	34 90	66 10	42 42	46 30	39 94	39 67	43 80	57 90	57 80	53 20	58 90	58 90	43 10	42 50	41 70	44 50	56 30
Weight per bu	28 75	29 50	26 50	26 50	22.50	32 00	32 00	31 50	30 50	28 00	30 50	29 50	29 50	27 00	28 50	30 42	30 33	29 17	28 00	26 33

*Damp and not averaged in

TABLE VII. Part B. Early and late seeding of oats.—Concluded.

	1909—Sixty Day				1910—Improved American				1911—Ohio 7009-Sixty Day				3 yr average—1909-10-11			
Date of seeding	3 23	4 13	4-23	5 5	3 22	4 1	4 14	4-30	3 22	4 11	4 27	5-8	3 22 to 23	4 1 to 13	4-14 to 27	4 30 to 5-8
Yield { Grain	66 56	65 08	67 11	67 42	72 50	66 87	50 00	40 31	68 28	60 31	49 53	44 50	69 11	64 09	55 55	50 74
Yield { Straw.	1,880	2,017	2 252	2 452	4,720	4,840	4,000	4,070	2 115	1,870	1 915	1,995	2,905	2 909	2,722	2,839
Straw per bu grain	28 20	31 00	33 60	36 40	65 10	72 40	80 00	101 00	31 00	31 00	40 80	42 60	41 40	44 80	51 50	60 00
Weight per bu	28 50	27 25	27.50	28 00	.				32 50	29 50	27 75	26 25	30 50	28 37	27 62	27 12

Regarding yield of grain, the Wideawake gave the highest yield from the use of eight pecks per acre; the Improved American from eleven pecks; the Siberian from nine pecks and the Sixty Day from nine pecks. Combining the results of the fourteen tests and deducting the amount of seed used, the figures show that the highest *net* yield came from the use of nine pecks per acre. Regarding weight per measured bushel, the nine-year average shows that it has generally increased with the rate of seeding. Averaging the weight per bushel of the lowest and highest three rates of seeding, there is a difference of 1.16 pounds in favor of the latter.

Regarding yield of straw, the variation has been slight with the different rates of seeding. The Improved American and Sixty Day have each given a trifle the highest yield with the eleven peck rate; the Wideawake with the eight peck rate and the Siberian with the four peck rate. All, with the exception of the Siberian, have given the lowest yield with the four peck rate; the Siberian with the twelve peck rate.

THE RELATION OF SIZE OF GRAIN TO YIELD

To get data regarding the value of the practice of using only the larger grains for seed; grains such as the farmer can get by running oats one or more times through a good fanning mill, an experiment was started in 1904, the details of which follow:

A quantity of a standard variety of oats—the Improved American—was repeatedly run through a fanning mill until three quite distinct grades were secured; grades which are here designated as "large," "small" and "light." In the cleaning process the grains were delivered into an upward wind blast and thereby separated into two classess—the "light," and a heavy class consisting of both large and small grains. The latter class was passed over a sieve which separated it into "large" and "small." Each grade was planted in duplicate on one-twentieth acre plots; in one set at a uniform rate by measure and in the duplicate set at a varied rate, the aim in the latter being to put on as nearly as possible the same number of grains per plot. The test was continued for five years in the manner above described. Each year the various grades of seed were prepared from a new stock.

Table IX gives data regarding the seed used, the crops harvested each year and the five-year average yield of grain and weight per bushel.

From the table may be noted the following: That, with the exception of the uniform seeding in 1905, the yield of the "large" exceeded that of the other two classes in both rates of seeding

TABLE VIII. Thick and thin seeding of oats.

Year	Pecks of seed per acre: 4	5	6	7	8	9	10	11	12	4	5	6	7	8	9	10	11	12
	Bushels of grain per acre									Pounds of straw per acre								
Wideawake																		
1903	39.37	41.44	39.64	43.35	48.31	47.03	46.79	49.29	44.52	1,664	1,683	1,681	1,727	1,898	1,760	1,757	1,807	1,639
1905	46.88	50.16	52.34	51.80	51.41	50.16	49.53	48.98	44 61	2,450	2,555	2,705	2,732	2,725	2,515	2,725	2,442	2,562
Average	43.12	45.80	45.99	47.57	49.86	48.59	48.16	49.13	44.56	2,057	2,119	2,193	2,229	2,311	2,137	2,241	2,124	2 100
Improved American																		
1905	52 42	55.08	56.25	56.02	60.16	59 59	59 22	62.97	58.28	2,342	2,337	2,300	2,257	2,315	2,492	2,505	2,605	2,375
1907	38 59	41.56	42.19	44.30	44 22	46.17	46.88	47 03	47.89	1,595	1,760	1,650	1,902	1,765	1,842	1,770	1,765	1,897
1908	67.19	70.23	72.27	71.25	67.89	69.92	69 14	69.14	70 00	2,500	2,712	2,707	2,620	2,627	2,782	2,917	2,837	2,930
1909	55.46	64.18	67.46	68 47	69.02	68 47	70.93	72 61	72.07	2,515	2,766	2,796	2 684	2,536	2,664	2,765	2,711	2,699
1911	39.69	42.50	41.17	41.48	41.01	37 11	37.03	39.21	38.59	1,560	1,560	1,642	1,602	1,567	1,272	1,265	1,475	1,295
Average	50.67	54 71	55.87	56.30	56.46	56.25	56.64	58.19	57.37	2,102	2,227	2,219	2,213	2,162	2,210	2,244	2,279	2,239
Siberian																		
1906	66.64	66.56	67.81	70.23	70.00	72.66	71.87	68.12	69 53	2,667	2,610	2,430	2,382	2,360	2,265	2,340	2,140	2,095
Sixty Day																		
1910	42.50	45 00	45 62	44.53	39.68	52.34	52.18	50.31	50 16	3,760	3,720	4,140	3,855	3,730	3,845	4,050	4,350	3,595
1912	50 62	58 51	59.92	58.43	62.58	61 48	56.87	57.81	60.78	1,527	1,765	1,862	2,055	2,117	1,922	1,830	1,817	1,805
Average	46.56	51.75	52.77	51.48	51.13	56.91	54.52	54.06	55.47	2,643	2,742	3,001	2,955	2,923	2,883	2,940	3,083	2,700
9-year av	49.94	53.52	54.47	54.99	55.43	56.49	56.04	56.55	55.64	2,258	2,347	2,391	2,382	2,364	2,336	2,392	2,395	2,289
9-yr. av. net yield	48.94	52.27	52.97	53.24	53.43	54.24	53.54	53 80	52.64									
	Weight per measured bushel—pounds																	
9-year.av		27.59	28.17	27.64	28.59	28.52	28.86	29.17	29.04									

every year; that upon the basis of the combined rates of seeding in the five-year average, the "large" exceeded the "small" by 4.28 bushels and the "light" by 4.17 bushels. The difference between the three regarding weight per bushel of crop harvested was practically negligible.

TABLE IX. The relation of size of kernel to yield.

Grade	Uniform seeding				Varied seeding			
	Bushels per acre	Weight per bu.	Pounds straw per		Bushels per acre	Weight per bu.	Pounds straw per	
			Acre	Bushel grain			Acre	Bushel grain
1904								
Large	61.25	35.50	2,310	37 7	61.25	35.50	2,310	37.7
Small	55.94	35.00	2,130	38 1	56.88	35.00	2,140	37 6
Light	57.81	34.00	2,330	40.3	55.31	33.75	2,270	41.0
1905								
Large	57.68	27.16	3,034	52.6	57.68	27.16	3,034	52.6
Small	57.81	27 50	3,120	54 0	54.53	26.25	3,355	61.5
Light	59.84	26.50	3,405	56.9	53.71	26.75	3,226	60.1
1906								
Large	70.65	29.08	3,399	48.1	70.65	29.08	3,399	48.1
Small	66 95	30 50	3,387	50 6	65.70	27.87	3,192	48 6
Light	67.18	30.00	3,570	53.1	63.04	27 25	2,962	47.0
1907								
Large	42.38	29.50	2,358	55.6	42.38	29 50	2,358	55.6
Small	39 13	29.75	2,697	68.9	38.50	30.75	2,597	67.5
Light	38.13	28.00	2,740	71.9	38.03	28.75	2,652	69.7
1908								
Large	62.50	24 87	2,700	43.2	62.50	24.87	2,700	43 2
Small	53.75	23 50	2,670	49 7	56.95	27.50	2,817	49.5
Light	55.55	27.75	2,872	51.7	58.67	28.75	2,672	45.5

Five-year average

Grade	Average weight per bushel		Bushels per acre			Pounds straw per acre		
	Seed used	Crop harvested	Uniform seeding	Varied seeding	Average of both series	Uniform seeding	Varied seeding	Average of both series
Large	32.12	29.22	58.89	58.89	58.89	2,760	2,760	2,760
Small	33 25	29 36	54.72	54.51	54 61	2,801	2,820	2,810
Light	25.50	29.15	55.70	53.75	54.72	2,983	2,756	2,869

This test was not altogether satisfactory for the reason that none of the three grades represented that which the farmer would have to sow without any cleaning.

To make the work conform more closely to practical conditions, the plan was slightly changed in 1909. The class of seed called "light" was discontinued and in its stead was substituted "unscreened" seed, i. e., seed as it comes directly from the thresher.

Furthermore, since that time the selection of seed has been continuous, i. e., the "large" has been prepared from the crop grown from "large" and likewise the "small" and "unscreened."

The results of the work since the change of plan are presented in Table X. It will be noted that with two exceptions—the uniform seeding of 1909 and 1910—the "large" seed has throughout the four years yielded higher than either of the other two classes, the difference, however, being slight as between it and the "unscreened" in the varied rate of seeding.

TABLE X. The relation of size of kernel to yield.

Grade	Seed used		Uniform seeding				Varied seeding			
	Wt per bushel	No per ounce	Bushels per acre	Wt per bushel	Pounds straw per		Bushels per acre	Wt. per bushel	Pounds straw per	
					Acre	Bushel grain			Acre	Bushel grain
1909										
Large	26 25	992	64 48	28 17	2 740	42 5	64 48	28 17	2,740	42 5
Small	31 00	1 868	67 19	30.00	2 730	40 6	62 03	25 00	3'035	48 9
Unscreened	27 75	1 270	66 56	29 00	2,830	42 5	63 67	26 50	3,142	49 3
1910										
Large	28 75	976	52 29		4 400	84 1	52 29		4,400	84 1
Small	33 25	1 782	55 00		4 840	88 0	50 62		4 180	82 6
Unscreened	27 25	1,279	53 12		4 500	84 7	52 19		4,130	79 1
1911										
Large	24 00	1 274	51 41	26 83	2 962	57 6	51 41	26 83	2,962	57 6
Small	26 25	1 715	50 00	27 50	3 160	63 2	47 81	28 00	3,010	63 2
Unscreened	24 00	1,400	49 53	26 00	3 275	66 1	51 25	27 25	2 680	52 3
1912										
Large	31 00	966	67 75	30 67	3 658	54 0	67 75	30 67	3,658	54 0
Small	32 25	1,372	59 84	29 50	3 825	63 9	60 78	30 50	3,675	60 4
Unscreened	30 00	1'196	64 53	28 00	3 635	56 3	65 00	30 00	3,920	60 3

Four-year average results

Grade	Seed used		Bushels per acre			Pounds straw per acre			Crop harvested. Av wt. per bu
	Wt per bushel	No per ounce	Uniform seeding	Varied seeding	Average of both series	Uniform seeding	Varied seeding	Average of both series	
Large.	27 50	1,052	58 98	58 98	58 98	3 440	3 440	3,440	28 56
Small	30 69	1,684	58 01	55 31	56 66	3,639	3 475	3 557	28 41
Unscreened	27 25	1,286	58 43	58 03	58 23	3,560	3,468	3,514	27 79

Nine-year average

Large			58 93	58 93	58 93	3,062	3,062	3,062	*28 97
Small			56 18	54 87	55 52	3,173	3,111	3,142	*29 01

*Eight year average.

Comparing the "large" and "unscreened" seed, or what the average farmer would properly term "cleaned" and "uncleaned" seed, the four-year average results show that in the uniform rate (the method followed in farm practice) the yield of the "large" exceeds that of the "unscreened" by only 0.55 bushel and in the varied rate by 0.95 bushel, thus making an average difference of 0.75 bushel, or three pecks. Regarding quality of crop harvested, there was a difference in weight per bushel of 0.77 pound.

While these results may not seem to encourage the use of the fanning mill, there is no question but that this implement has a place in removing broken and shrunken grains and all foreign substances, such as weed seed, broken straw, chaff, etc., from the seed. The above results are quite in line with the work of the Nebraska Experiment Station.*

Moreover, that such cleaning is an efficient means by which to maintain quality and purity, and to prevent the so-called "running out" of seed, is attested by the fact that some of the best varieties this Station is now growing are varieties which have been thus cleaned and grown without change of seed for the past twenty odd years.

Though the "small" seed is unlike that obtained by the farmer in ordinary cleaning, yet a comparison of it and the "large" is of interest from a scientific standpoint, as such comparison has a bearing on the much discussed question regarding the relative value of "large" and "small" seed.

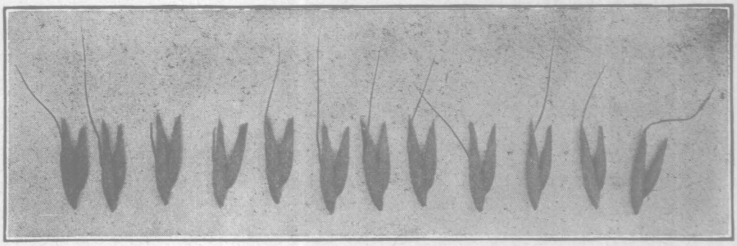
Since the method of separation of the "large" and "small" seed has remained constant throughout the test, the results from these two grades are comparable for the entire nine years, and upon that basis the "large" has exceeded the "small" in the uniform and varied rates by 2.75 and 4.06 bushels, respectively, and on the average of both series by 3.41 bushels. As regards quality, the eight-year average weight per bushel showed a difference of 0.04 pound, which, of course, is negligible.

The results of this test relative to the value of "large" and "small" seed are in harmony with those obtained in the Station's plant-row work, where the separations of large and small grains were made by hand.

A comparison of primary and secondary grains: In this work, which extended through the five years, 1908-1912, the grains from 1,553 individual heads, representing twelve varieties of oats, were hand-sorted into two classes, the primary—the lower grain of the

*Nebraska Bulletin 104.

spikelet, and the secondary—the upper grain. See illustration below. So far as quantity of seed would permit, thirty primary and twenty secondary grains from each individual head were hand-planted in uniform soil in separate beds in rows one foot apart, the grains being dropped three inches apart in the row.



Of the crops harvested during the five years' test the yield per row of uniform length was computed for both the primary and secondary grains from the same heads. The results, expressed in grams, are shown in Table XI.

TABLE XI. Primary vs. secondary grains from 1,553 individual heads.

Year	Number of heads	Yield per row of 7½ ft. (grams)	
		Primary	Secondary
1908	126	86.9	90.9
1909	101	127.9	102.2
1910	56	156.9	156.9
1911	326	97.0	94.4
1912	944	202.0	188.4
Five year average*	...	164.2	154.0

*Computed by dividing the sum of the total yield of all rows for each year by the total number of heads.

In this test the two sets of grains compared are of the same heredity. Apparently the primary grains are somewhat more productive than the secondary. The gain of the primary over the secondary grains is 6.6 percent. In the machine-selected seed previously reported, the gain of the large grains over the small (See Table X, the nine-year average yield of both series) is 6.1 percent. As has been noted, these results are in close harmony. While it is doubtless true that the bulk of the small grains in the machine test are secondary grains, we do not have the absolute proof of it as in the hand-selected seed.

IMPORTED VS. HOME-GROWN OR ACCLIMATED SEED

To get facts regarding the advisability of importing seed oats when for any reason the supply of Ohio seed is short, the Station has imported and grown seed from various sources.

TABLE XII. Oats from Southern Ohio in Northern Ohio.

Increase (+) or decrease (—) in yield per acre and increase or decrease in weight per bushel, each year, as compared with the average of twenty-two varieties among which they have been grown.

Source of seed	1909		1910		1911		1912		Average	
	Yield bus.	Weight lbs.	Yield bus.	Weight lbs.	Yield bus.	Weight lbs.	Yield bus.	Weight lbs.	Yield bus.	Weight lbs.
Carpenter, Meigs Co	—1.18	+0.25	—1.57	+2 25	—0.30	0.00	+1.36	+1 00	—0 42	+0.87
Germantown, Montgomery Co	...	....	—2 06	+1.75	+5.45	+0 50	....	....	+1.69	+1.12

TABLE XIII. Oats from the Northwest in Northern Ohio

Increase (+) or decrease (—) in yield per acre and increase or decrease in weight per bushel, each year, as compared with the average of twenty-two varieties among which they have been grown.

Source of seed	1908		1909		1910		1911		1912		Average	
	Yield bus.	Weight lbs.	Yield bus.	Weight lbs	Yield bus.	Weight lbs.	Yield bus.	Weight lbs.	Yield bus.	Weight lbs.	Yield bus.	Weight lbs.
Manitoba	..	....	....	....	....	....	....	...	+10.36	—0 75	+10 36	—0.75
Montana	+3.65	..	...	...	....	....	....	..	.	..	+3.65	.
North Dakota	—11.46	....	+3.26	0.00	—6.40	+2.50	+5.11	0 00	+6.17	+0.50	—0.66	+0.75
Wisconsin	...	....	—6 76	+1.12	. .	....	—6 69	—1.12	+9 95	—1.50	—1.17	—0.50

To study the effect of southern climatic conditions on seed subsequently grown in the north, the Station, in 1908, imported a quantity of Sixty Day oats from the State of North Dakota, a part of which was grown at Wooster, reference to which will be made later, and a part at each of the test farms located at Carpenter and Germantown, the former being approximately 110 miles due south and the latter approximately 80 south and 125 miles west of Wooster.

In 1909 seed from the 1908 Carpenter* crop was grown at Wooster beside home-grown Sixty Day oats, i. e., beside Sixty Day oats which had been grown at Wooster continuously since 1904. In 1910 seed from both the 1909 Carpenter and Germantown crops was grown at Wooster beside home-grown Sixty Day oats as in 1909. In this manner the work was continued through 1911 and 1912, with the exception that in the latter year no seed from Germantown was available. The results which are presented in Table XII indicate that the southern sojourn was not especially harmful.

To study the value of seed oats grown in the northwest the Station has in the past five years imported and grown upon one-tenth acre plots and beside the same variety of home-grown seed, and in the years as indicated, the following varieties from the following places: In 1908, the Big Four and Swedish Select from Montana and the Sixty Day from North Dakota; in 1909, the Sixty Day from North Dakota and the Silver Mine and Sixty Day from Wisconsin; in 1910, the Sixty Day from North Dakota; in 1911, the Big Four and Silver Mine from Wisconsin and the Sixty Day from North Dakota, and in 1912, the Sixty Day from North Dakota and the Swedish Select† from Manitoba and Wisconsin.

The results of this work which are presented in Table XIII show that in the single years that seed was imported from Manitoba and Montana it yielded higher than the home-grown seed; that the yield from the seed from North Dakota and Wisconsin has fluctuated from year to year and that the average of each falls a shade only below that of the home-grown seed and that in all cases the variation in quality is quite negligible. When two varieties have been imported from the same source, the same year, the figures in the table represent the average of the two.

Further information regarding the effect of Ohio environment on northern grown seed is given in Table XIV. These two varieties from Canada—the Siberian and Joanette—weighed, when introduced, twelve pounds per bushel more than the average of our own varieties.

*At Germantown the 1908 crop failed. Seed for the 1909 crop was shipped from Carpenter.

†Part of quadrangular test in cooperation with U. S. D. A.

TABLE XIV. Oats from Canada in Northern Ohio.

Increase (+) or decrease (—) in yield per acre and increase or decrease in weight per bushel, each year, as compared with the average of twenty-two varieties among which they have been continuously grown.

Variety	1904		1905		1906		1907		1908		1909		1910		1911		1912		Four-year average			
																			1904-1907		1909-1912	
	Yield bus.	Wt. lbs.	Yield bus.	Wt. lbs.	Yield bus.	Wt. lbs.	Yield bus.	Wt. lbs.	Yield bus.	Wt. lbs.	Yield bus.	Wt. lbs.	Yield bus.	Wt. lbs.	Yield bus.	Wt. lbs	Yield bus.	Wt. lbs.	Yield bus.	Wt. lbs.	Yield bus.	Wt. lbs.
Siberian	+15.75	+0 32	+6.68	+0.63	+0.76	+0.40	+3 19	−2.55	+3.82	+1 11	+6 13	−0 48	+11.08	−2 00	+6 10	−0.13	+0.50	−0.42	+6.59	−0.30	+5.95	−0.76
Joanette	+1.85	−0.18	+7.99	+0.01	+3.14	+0.15	−2.29	−1 05	+11.88	+4.61	+2.15	−0 98	−13.65	0.00	+1.19	+0 62	+4 97	+1 08	+2.67	−0.27	−1.33	+0.18
Average	+8.80	+0.07	+7.33	+0.32	+1.95	+0.27	+0.45	−1.80	+7.85	+2.86	+4.14	−0.73	−1.28	−1.00	+3.64	+0 24	+2 73	+0.33	+4.63	−0.28	+2.31	−0.29

TABLE XV. Oats from Sweden and England in Northern Ohio.

Increase (+) or decrease (—) in yield per acre and increase or decrease in weight per bushel, each year, as compared with the average of twenty-two varieties among which they have been continuously grown.

Variety	1908		1909		1910		1911		1912		Two-year average			
											1908—1909		1911—1912	
	Yield bus.	Wt. lbs.	Yield bus.	Wt. lbs.	Yield bus.	Wt. lbs.	Yield bus.	Wt. lbs.	Yield bus.	Wt. lbs.	Yield bus.	Wt. lbs.	Yield bus.	Wt. lbs.
Beardless Propsteier	−8.07	−0.14	−2 55	+0.39	−12 64	−2.25	−4.14	−0.88	+0 16	+0.33	−5.31	+0.12	−1.99	−0.27
Black Mogul	−17 56	−3.89	−12.76	−6.98	−12.46	−4.50	−32.21	−2 38	−25.01	−5.42	−15.16	−5.43	−28.61	−3.90
Golden Rain	+0.17	+5.36	+7.30	+2.52	+3.69	+1.50	+4.26	+1.62	+4.47	+2 33	+3.73	+3.94	+4 36	+1.97
Hvitling	+1.74	+2.61	+3.87	−2.48	−16.03	−1.00	−7 63	−1 13	−8.51	+1.08	+2.80	−0 06	−8 07	−0.02
White Ligowa	+3.60	+2.39	−2.62	+0 52	−5 21	−1.75	−4 54	+0 87	−3.94	+0.33	+0.49	+1.45	−4 24	+0.60
White Propsteier	−7.71	−0.14	+0.06	−2 61	−4.55	−3 00	−8 59	−1.13	+3.72	+1.08	−3 82	−1 37	−2 43	−0.02
Regenerated Swedish Select	+0.56	+2 11	−6 17	−1.23	−6 19	+1.00	−6 26	−0.88	−5.73	+1.33	−2.80	+0.44	−5.99	+0.22
Average	−3.90	+1.19	−1 84	−1.41	−7.63	−1.43	−8.44	−0.56	−4.98	+0 15	−2 87	−0.13	−6.71	−0.20

That little or no change due to more complete acclimatization has taken place in the varieties, either as regards yield or quality of grain, is shown by a comparison of the four-year average yields for the first and last four-year periods of the test; a comparison which reveals that both have a wider lead in yield during the first than they have during the second period.

Further data regarding the gradual acclimatization of oats is given in Table XV. The first six varieties in this table were imported from Svalof, Sweden, in 1908, and the last—the Regenerated Swedish Select—from the Garton Bros., of England, in the same year. All have been grown each season from 1908-1912, inclusive. The Golden Rain seems to be a promising variety; the others mediocre or below par. That time is not, on the whole, working a general improvement, either as regards yield or quality, is shown by a comparison of the yield and weight per bushel, upon the basis of the average for the first and last two years of the test.

It should perhaps be stated that the twenty-two varieties with which those in Tables XIV and XV have been compared, are the same. Taken as a whole, the results indicate that seed oats from the north and northwest may be expected to yield about the same as home-grown seed, and that they gain little by acclimatization. Barring exceptional cases, importations from across the water hold out little hope of improvement for Ohio conditions.

THE PROTEIN CONTENT OF OATS

The esteem in which oats are held as food for livestock, especially for young animals and for the maintenance of those doing heavy work, is due, largely, to their high content of protein, the digestibility of which is made rather easy by the presence of a considerable amount of crude fiber in the hull.

That there is little choice of varieties from the standpoint of protein content, as grown under Ohio conditions, is shown by Table XVI, which gives data on twenty different varieties relative to protein content and weight per bushel.

In this table it may be noted that the difference between the extremes in percentage composition is only 1.54 percent, and in total pounds of protein per acre is only 67.7 pounds. The latter is based on six-year average protein content and on nine-year average yields.

Perhaps attention should be called to the fact that the rank of the various varieties as based upon the six-year average percentage composition is quite different from that based upon the total yield of protein per acre. The fact that a variety has a low percentage composition does not necessarily mean that it is a low yielder of protein per acre.

TABLE XVI. The protein content of oats.

Variety	1905		1906		1908		1909		1911		1912		Six-year av.		Nine-year av. yield per acre	Lbs. protein per acre
	Percent protein	Wt. per bu.	Percent protein	Wt. per bu.	Percent protein	Wt. per bu.	Percent protein	Wt. per bu.	Percent protein	Wt. per bu.	Percent protein	Wt. per bu.	Percent protein	Wt. per bu.		
Alaska	12.44	28.25	14.78	32.25	13.72	23.00	14.75	27.50	16.28	27.00	11 62	32 50	13.93	28.42	62.96	280.7
Big Four	13.66	29.50	13.63	30 25	13.62	24.50	13.66	28 25	15.56	29.50	11.81	33.50	13.66	29.25	70.49	308.1
Czar of Russia	12.50	30.00	14.87	28.50	14.78	24 25	13.66	27.25	17.34	27.75	13 06	31.50	14.37	28 21	68.02	312.8
Early Champion	12.97	29.50	14.34	32.50	13.63	21 00	15.34	27.25	15.78	29 00	12.06	33.00	14.02	28.71	61.37	275.3
Golden Fleece	16.12	29.00	15.22	26 50	15.47	24.50	13.47	28,75	15.87	26.50	12.56	34.00	14 78	28,21	62 83	297.2
Improved American	15.50	24.50	15.22	25.50	13.81	24.50	13.34	25 00	15.78	29.50	13.19	32 00	14.47	26.83	69.43	321.5
Joanette	14 63	27.50	13 84	28.50	14.50	28.00	14.03	26.00	15.75	28.25	11.87	34.00	14.10	28.71	67.24	303.4
Lincoln	13.66	28.00	13.94	30.00	....	21.50	12 25	27.50	15.25	29.00	11.75	33.25	13.37	28.21	67.31	288.0
Long's White Tartar	14.09	26.50	15.31	31.25	12 66	23.50	14 59	28.25	15.19	29.25	12.69	34.25	14.09	28.83	65.16	293.8
Morgan Feller	15 03	28.00	14.00	26.50	12.50	23.25	13 81	28.00	16.47	25.00	12.56	31.50	14.08	27.04	65.98	297.3
Seizure	11.50	24.00	13.81	24 75	13.40	20.00	13.25	25 25	15 75	27.00	11.75	32 00	13.24	25.50	61.13	259 0
Siberian	14.06	28 12	13.75	28.75	13.94	24.50	13.53	26.50	15.56	27 50	13.06	32.50	13.98	27.98	71.33	319.1
Silver Mine	13 56	31.50	13.44	30.50	13 62	21.50	13.66	25 00	15.06	29.00	11.69	33.50	13.50	28.50	69 80	301 6
Sixty Day	13.47	27.00	14.13	28.75	15 53	25 00	15.31	25·75	14.94	29 50	12.87	31.50	14 37	27.92	68.23	313.7
Sparrowbill	14.66	22.00	15 28	29.50	13.69	22.00	13.15	28.75	16.43	27.25	12.25	35 00	14.24	27.42	*55.70	253 8
Swedish Select	14.56	26 50	15 34	25.87	14.47	23.75	13.78	28.25	.....	25.25	12 81	35.00	14.19	27.44	61.46	279 1
Twentieth Century	15.34	28.50	14.78	27.00	14.22	24 00	13.47	28 50	16.43	26.25	12 05	33.00	14.38	27.87	63.25	291.1
Watson	15.41	27.25	14 69	31 25	12.50	22 25	12.78	26.75	15.16	....	12.50	.....	13.84	26 87	62 00	274.6
Welcome	12.69	26.50	13.56	26.75	13.93	22.00	12 28	24.25	15.31	28.00	12.22	31.00	13.33	26.42	62.90	268.3
Wideawake	13.63	27.56	14 81	28 35	13 87	28.19	15.67	26.00	16.37	27.07	12.47	33.42	14.47	28.43	60.49	280.1
Average of 20 varieties	13.97	27.48	14.44	28.66	13 89	23.56	13 79	26.94	15.80	27.77	12.32	32.97	14.02	27.84	64.85	290.9
Barley	.....	.....	13.00	38.50	14.75	40.75	15.75	40.75	13 69	34.50	....	.....	†14 30	38.62	†31.67	†217.4
Emmer	.....	... .	14 22	39.75	... .	.....	17.03	18.25	14 94	27.25	14.00	26.50	†15 05	25.44	†29.47	†177.4

*Seven-year average. †Four-year average.

It should be mentioned in this connection that the seven varieties which have produced more than 300 pounds per acre of protein, include the five varieties ranking highest from the standpoint of the nine-year average yield of grain. (See Table II.)

With respect to seasons, the average of twenty varieties, given at the bottom of Table XVI, shows considerable variation in both percentage of protein and in weight per bushel; the difference in the former being 3.48 percent and in the latter, 9.41 pounds.

In 1912, heavy weight per bushel was associated with low percentage of protein, but this relationship is not closely maintained throughout the other years.

A probable explanation of the seasonal differences as regards protein content is found in the annual rainfall. Ranking the years upon the basis of the protein content for each season, placing at the top the year in which the protein content was highest, the Station's weather records show that with one exception—1905—the protein content decreases as the rainfall increases. This relationship holds not only for the growing season but also for the entire year—August to July, inclusive. These facts are better brought out in Table XVII.

TABLE XVII. Relation of protein content to rainfall.

Year	Rainfall (inches)		Percent of protein	Date of harvest
	August to July inclusive	March to July inclusive	Average of 20 varieties	
1911	36.37	16.56	15 80	7-21
1906	36 56	17 56	14 44	7-23
1905	35 17	23 73	13.97	....
1908	36 93	18 83	13.89	7-20
1909	38 92	21 49	13.79	7-30
1912	52.76	24.67	12.32	7-27
25-year average	39.63	18.96	.....	....

From these figures it would seem that, under conditions prevailing at Wooster, the protein content of oats may be expected to vary inversely with the rainfall, especially with that in the growing season.

These results are in accord with those obtained by Director Thatcher, of the Washington Experiment Station, in his investigations of the relation of the protein content of wheat to rainfall.*

BARLEY AND OTHER SPRING CROPS

A few spring grains have been tested from time to time in the hope of finding something which, in case of necessity, might be substituted for oats. The yield of the crops included in these tests

*Proceedings of the American Society of Agronomy, Vol. 3, pp. 42-45.

TABLE XVIII. Barley and other spring crops.

Crop	Name of Variety	Pounds of grain and straw per acre											Lbs. straw per bu. grain	Av. wt. per bushel
		Grain									Average			
		1904	1905	1906	1907	1908	1909	1910	1911	1912	Grain	Straw		
Barley	Ohio Beardless	1,242	877	.....	.....	.....	.....	.....	.....	.....	1,059	1,286	58	38.00
	Champion Beardless	.....	.....	1,567	.....	*	.....	. ..	.....	....	1,567	1,532	47	37.00
	Highland Chief	930	....	... .	.....	.....	.....	.....	. ...	.....	930	2,130	110	43.50
	Black Hulless	2,010	1,062	1,442	.....	.....	.....	.....	.....	....	1,505	2,432	78	58 00
	Manshury	1,850	1,887	2,002	.....	.....	.....	.....	.....	.....	1,913	2,110	53	38.62
	Primus	.. ..	. ..	.....	.....	1,755	432	1,640	.....	.....	1,276	2,787	105	42.00
	Princess	....	.....	.....	....	1,675	1,182	1,637	. .	....	1,498	2,928	93	41 50
	Oderbrucker	.....	.....	. ...	.....	2,115	1,815	2,145	680	1,652	1,681	2,148	61	38.56
	Wisconsin Pedigreed	.....	.....	.....	....	... .	.....	.....	. ...	1,570	1,570	2,380	73	41 50
Spring wheat	Wild Goose	840	940	700	...	.....	.....	.....	. ...	... .	827	3,583	260	42.37
	Durum	.. .	.. .	882	..	†1,090	†985	†700	. ...	275	786	2,523	193	42 94
	Minnesota No. 169	.....	.....	520	460	.....	.....	.....	..	... .	490	1,680	206	39 00
	Groff	.....	. ..	...	..	.....	1,510	1,340	460	607	979	2,823	173	57.00
	Blue Ribbon	.....	.....	...	...	.....	.....	....	..	590	590	1,930	196	58.50
Spring rye	Mammoth	.. .	.....	...	1,005	1,435	1,222	737	.....	... .	1,100	3,196	163	51.25
Emmer	.....	1,645	910	1,275	1,450	1,782	732	550	927	792	1,118	2,423	87	27.72
Oats	Siberian	2,997	2,083	2,524	1,570	2,100	2,283	2,452	2,155	2,379	2,283	3,022	42	28 26
	Big Four	2,634	2,191	2,663	1,575	1,870	2,143	2 426	2,235	2,561	2,255	3,003	42	29 78
	Silver Mine	2,690	2,064	2,642	1,508	1,924	2,156	2 305	2,271	2,540	2,233	3,009	43	29 50
	Improved American	2,741	1,902	2,791	1,455	2,150	2,452	2,031	2 106	2,466	2,233	3,248	47	27 93
	Sixty Day	2,789	1,780	2,284	1,822	2,423	2,295	2,268	1,643	2,346	2,183	2,254	33	27 50
	Average of twenty-two varieties	2,493	1,869	2,500	1,468	1,978	2,087	2,097	1,960	2,363	2,091	3,100	47	28.61

*Seed of this variety failed to grow. †Kubanka variety.

and the yields of oats with which they are compared, are given in Table XVIII. All are expressed in pounds per acre, on account of differences as regards weight per bushel.

A comparison of the yield of the various spring crops with the average yield of twenty-two varieties of oats for the same period, shows that the oats excel all the barleys, approximately, as follows: The Ohio Beardless by 106 percent, the Champion Beardless by 60 percent, the Highland Chief by 168 percent, the Black Hulless by 52 percent, the Manshury by 20 percent, the Primus by 61 percent, the Princess by 37 percent. the Oderbrucker by 25 percent and the Wisconsin Pedigreed by 51 percent. The spring wheats as follows: The Wild Goose by 177 percent, the Durum by 181 percent, the Minnesota No. 169 by 305 percent, the Groff by 117 percent, and the Blue Ribbon by 301 percent. The Mammoth Spring Rye by 73 percent and the Emmer (commonly though improperly called Speltz or Spelt) by 87 percent.

From these figures it is evident that the Manshury and Oderbrucker barleys are the only crops which offer much competition with the oats. Three times in the course of this test, which covers nine years, the average yield of twenty-two varieties of oats has been exceeded by that of these barleys, but in each of these years the barleys have been surpassed by some of the best varieties of oats, as shown at the bottom of Table XVIII.

For a comparison of oats and barley as regards feeding value, see Table XIX, in which is given the digestible nutrients in 100 pounds of each.

TABLE XIX.* Digestible nutrients in 100 pounds of—

Crop	Dry matter Lbs.	Protein Lbs.	Carbohydrates Lbs.	Fat Lbs.
Oats	89 6	10 7	50 3	3 8
Barley	89.2	8 4	65 3	1 6

*Henry's Feeds and Feeding.

For a comparison of barley and emmer with oats, with respect to protein content and weight per bushel, as grown under Ohio conditions, see bottom of Table XVI.

Regarding spring wheat, the yields of all varieties of which have been uniformly low, it should perhaps be added that, with one exception, the quality of the grain has been such that it was fit only for use as stock food.

Emmer is quite resistant to drouth and for that reason is a success in the semi-arid regions of the northwest. Under Ohio conditions, however, it holds out little hope as an economical substitute for oats.

SUMMARY

1. **Varieties.** Of the varieties tested throughout the past nine years, the highest five in the order of their rank are: Siberian, Big Four, Silver Mine, Improved American and Sixty Day.

2. **Fertilization.** On a fifty-acre tract of land, the judicious use of manure, fertilizer and limestone in connection with a systematic rotation of corn, oats, wheat and clover, has resulted in a net annual return per acre of $6.50.

3. **Preparation of seed bed.** On the basis of the average of eight tests extending through four years, the yield of disked plots exceeds those of plowed and no previous preparation plots by 3.34 and 4.63 bushels, respectively.

4. **Time of seeding.** On an average of six years' work, in which the extreme dates of seeding were March 22 and May 10, the results have generally favored the earlier seedings.

5. **Rate of seeding.** As an average of nine years' work, in which the rates of seeding per acre have varied by one peck and have ranged from four to twelve pecks inclusive, the highest net yield per acre has been secured from the use of nine pecks per acre.

6. **Quality of seed.** In field work where the separation of seed was made by means of a fanning mill, the yield of the "large" exceeded that of the "unscreened" by three pecks per acre. This as an average of four years' work. As an average of nine years' work the yield of the "large" exceeded that of the "small" in the uniform and varied rates of seeding by 2.75 and 4.06 bushels respectively, and on the average of both rates by 3.41 bushels. As regards quality of the two, there was no noticeable difference.

7. **Imported seed.** Oats from the north and northwest may be expected to yield about the same as home-grown seed and they seem to gain little from acclimatization.

With one exception, the seven varieties introduced from Sweden and England in 1908 have been found inferior to the average of our home-grown varieties.

8. **Protein content.** In protein content little difference was found in different varieties, but with respect to seasons the variation was quite marked and, with the exception of one year, varied inversely with the rainfall.

9. **Barley and other spring crops.** No spring crop has been found equal to oats under conditions such as prevail at Wooster. Barley, and especially the Oderbrucker variety, is the most promising substitute discovered thus far.

ACKNOWLEDGMENT

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